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NASA TECH BRIEF

Marshall Space Flight Center

Titanium Alloy Stress Corrosion Cracking in Presence of Dinitrogen Tetroxide

A report has been published which discusses interactions between liquid dinitrogen tetroxide (N_2O_4) and 6Al-4V-titanium alloy that lead to stress corrosion cracking. The study was almost exclusively focused on establishing the chemical composition of the minor constituents of reactive and nonreactive N_2O_4 systems. As a result of this effort, a satisfactory stress corrosion cracking test was developed and found to give extremely consistent results. Six new analytical methods were developed that are capable of detecting and determining significant differences in the minor constituent composition of different types of N_2O_4. These include:

(1) combined nitric oxide (visible spectrophotometer);
(2) total protons;
(3) distribution of protonated species (near-infrared spectroscopy);
(4) dissolved oxygen (gas chromatography);
(5) combined chlorine (x-ray fluorescence); and
(6) metallic impurities (atomic absorption).

Methods (1) and (4) permit analyses to be made at previously unattainable low levels. Method (2) represents a major analytical breakthrough. It is now possible to establish the amount and nature of the protonated species in samples of liquid N_2O_4. Oxygenated N_2O_4 was found to contain only HNO_3; nonoxygenated N_2O_4 was found to contain variable amounts of HNO_3, HNO_2, and H_2O. In addition, techniques were developed for the quantitative adjustment of the minor constituent composition of N_2O_4 systems, including a method for substantially reducing the level of protonated species.

By application of the above techniques and methods, it was possible to prepare and test a wide variety of N_2O_4 compositions. As a result, the stress corrosion cracking (SCC) test behavior of 6Al-4V-titanium alloy in the commonly encountered types of commercial N_2O_4 was established. Correlation of combined NO-protonated species concentrations with SCC test behavior was partially achieved in terms of critical concentrations. An interdependency between combined NO and protonated species concentrations was shown to relate to SCC test behavior. An attempt also was made to establish the effect of dissolved O_2 concentration.

It is now believed that the presence of HNO_2 and/or H_2O species in N_2O_4 are the main critical indicators of a nonreactive system that is free of extraneous contamination. However, the nature of the inhibitory process has not been established. The available evidence appears to favor the hypothesis of an oxidative attack mechanism, although the specific nature of the attacking species remains unknown.

Note:

Additional information may be obtained from:

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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

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